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THE ULVACEAE OF NORTH AMERICA.

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THE family *Ulvaceae* is here taken in the same limitations as by Wille in Engler & Prantl¹ excluding, the genera *Pringsheimia* and *Protoderma*, considered doubtful by him. The red algae, *Bangia*, *Porphyra* etc., included by earlier authors, are now generally recognized as belonging to the *Rhodospermeae*, the last important work including them among the *Ulvaceae* being J. G. Agardh's monograph.² This work has been here used as the basis for generic and specific divisions for the remainder, though somewhat modified by later publications, especially by Rosenvinge.³

There has been no general paper on the North American algae, with descriptions, since Harvey's.⁴ In this, *Porphyra*, etc., were included in the *Ulvaceae*, as was usual at that time. Excluding these there are described two genera and nine species. In Farlow's list of 1876⁵ there are two genera and six species. Since this no general list has been published, but in 1881 Farlow's Manual⁶ contained two genera, eight species and six varieties, for the New England Coast, and the progress since then may be shown by the fact that the list

¹ A. Engler & K. Prantl, Die Natürlichen Pflanzenfamilien, I. Abt. 2, 1897.

² J. G. Agardh, Till Alg. Syst. part 3, Lunds Univ. Årsskrift, Vol. XIX, 1882.

³ L. Kolderup Rosenvinge, Grønlands Havalger. Meddelelser om Grønland. Kjobehavn, 1893.

⁴ W. H. Harvey, Nereis Boreali-Americana, part III. Chlorospermeae. Smithsonian Contributions to Knowledge. Washington, 1858.

⁵ W. G. Farlow, List of the Marine Algae of the United States. Report of the U. S. Fish Commission for 1875. Washington, 1876.

⁶ W. G. Farlow, Marine Algae of New England and the adjacent coast. Report of U. S. Fish Commission for 1879. Washington, 1881.

published by the writer in 1900¹ gives from New England four genera, with twenty-six species, and six varieties. The present paper gives four genera, with thirty-three species, and twenty-six varieties, fifty-nine species and varieties as compared with Harvey's nine in 1856 and Farlow's six in 1876. Of many of these species no description is to be found in English, and no complete or nearly complete list with descriptions is to be found in any language; so that a paper of the present scope would seem to be of use. The region covered is the North American continent, with Greenland and the Alaskan islands. Some indication is also given of extra-limital distribution.

In distinction from some other green algae, also of wide distribution and common occurrence,—the Cladophoras, for instance, in which specific distinctions are based on characters discernible with the naked eye or at most with a pocket lens,—few of the *Ulvaceae* can be distinguished except by microscopic examination. The external form of the frond certainly counts for something, but only in connection with characters of the individual cell. The type of structure is a flat membrane composed of a single layer of cells, side by side, all similar except at the base of the frond, where they are usually modified for the purpose of giving a firmer attachment to the substratum. In manner of reproduction there is no distinction to be made, and, with the exception of the basal cells referred to, any cell may develop the zoospores which are the only form of reproduction known. Generic and specific distinctions are therefore based on vegetative characters.

In some forms the membrane is developed very soon after the germination of the spore, but in all species there is probably a filamentous stage, though it may be only of a few cells. In the genus *Monostroma* the filament develops into a sac of a more or less clavate form. In some species this soon splits, and thereafter the plant grows as a flat membrane; at the other extreme in this genus we have a persistent nearly cylindrical sac, never splitting, and opening at the top only in fructification. Between these two all intermediate forms can be found in the various species. When the sac continues permanently closed except from external causes, we have the genus *Enteromorpha*, in which the species range from broadly clavate to filiform, and from simple to much branched; in *E. percursea* the cells of the

¹ RHODORA, Vol. II, 41, 1900.

original monosiphonous filament divide longitudinally, forming two parallel series, and there is no further development. This is so different from most *Enteromorpha* species that this has been often kept as a separate genus, *Tetranema*, *Diplonema* or *Percursaria*; but there are undoubted species of *Enteromorpha* in which the most of the frond is of the normal form, while the tips of the branches are of the *Tetranema* type; so that it seems better to consider this very simple form as merely a case where the development stops at an early stage. In most species of *Enteromorpha* the tubular or saccate form continues through life, with or without branching; but in *E. Linza* the membrane on opposite sides adheres more or less, the frond becoming flat in the middle with open spaces at the edges. This type leads to *Ulva*, in which the membranes adhere throughout, forming a flat expansion, two layers of cells in thickness.

The specific distinctions are based somewhat on the general form of the frond, but more on the size and shape of the cells and their arrangement. The latter, as seen in a superficial view of the frond, ranges from *Ulva Lactuca* with irregular polygonal cells closely set in no definite order, to *Ilea fulvescens* with cells of circular outline, in groups of twos, fours, or their multiples, arranged in longitudinal series. The shape of the cells as shown in a cross section of the frond is also important, as well as the character of the individual cell wall and of the membrane generally. All our species are marine, but some extend into brackish, and rarely into quite fresh water.

As the species now acknowledged have been largely formed by segregation from older species, and as in the earlier American literature little or no attention was given to microscopic characters, all the forms being divided among a few common species, it is evident that where these common species are quoted in the older works there must be doubt as to which of our present species are meant. The result is quite a list of doubtful references, and also some uncertainty in cases where the writer has ventured to decide on what seems good authority, but without seeing actual specimens. But this is unavoidable in such cases. In the following list the writer has endeavored to make as complete as possible the references to American literature, but no such attempt has been made with foreign references, and apart from the citation of the original description, Agardh's monograph and De Toni's Sylloge¹ are the principal works cited. Refer-

¹J. B. De Toni, Sylloge Algarum Omnium hucusque cognitarum. Vol. I. Patavii, 1889.

ences have been made by number to the principal American exsiccatae: Farlow, Anderson & Eaton, *Algae Americae-Borealis*; Collins, Holden & Setchell, *Phycotheca Boreali-Americana*; Tilden, *American Algae*. A specific key is suggested under each genus, but it is impossible to make a key that will give satisfactory results in every case.

BIBLIOGRAPHY.

- Anderson, Charles Lewis.** (1.) List of California Marine Algae, Zoe, Vol. II. San Francisco, 1891.
- Anderson, F. W. & Kelsey, Francis D.** (1.) Common and Conspicuous Algae of Montana. Bull. Torr. Bot. Club, Vol. XVIII, 1891.
- Ashmead, Samuel.** (1.) Catalogue of Marine Algae discovered at Beesley's Point, during the past summer, with some remarks thereon. Proc. Phil. Acad. Vol. VII, 1855. (2.) Enumeration of the Arctic Plants collected by Dr. S. I. Hayes in his exploration of Smith's Sound, etc. Proc. Phil. Acad. Vol. XV, 1863.
- Bailey, Jacob Whitman.** (1.) Notes on the Algae of the United States. Amer. Jour. Sci. ser. 2, Vol. III, 1847.
- Bennett, James Lawrence.** (1.) Plants of Rhode Island. Proc. Providence Franklin Soc. 1888.
- Britton, Nathaniel Lord.** (1.) Catalogue of Plants found in New Jersey. Final Report of the State Geologist, Vol. II. Trenton, New Jersey, 1889.
- Collins, Frank Shipley.** (1.) Notes on New England Algae, Bull. Torr. Bot. Club, Vol. IX, 1882. (2.) l. c. Vol. XI, 1884. (3.) Vol. XV, 1888. (4.) Vol. XVIII, 1891. (5.) Vol. XXIII, 1896. (6.) Marine Algae of Nantucket, in Owen, Maria L., A Catalogue of Plants of the County of Nantucket. Northampton, 1888. (7.) Algae in Rand, E. L. & Redfield, J. H., Flora of Mount Desert Island, Maine. Cambridge, 1894. (8.) RHODORA, Vol. II, 1900.
- Curtis, Moses Ashley.** (1.) Geological and Natural History Survey of North Carolina, Part 3, Botany. Raleigh, 1867.
- Dame, Lorin Low & Collins, Frank Shipley.** (1.) Flora of Middlesex County, Massachusetts. Malden, 1888.
- Eaton, Daniel Cady.** (1.) List of Marine Algae collected near

Eastport, Maine, in August and September, 1872. Trans. Conn. Acad. Vol. II. New Haven, 1873. (2.) A List of the Marine Algae collected by Dr. Edward Palmer on the coast of Florida and at Nassau, Bahama Islands, March–August, 1874. New Haven, 1875.

Farlow, William Gilson. (1.) List of the Sea-Weeds or Marine Algae of the South Coast of New England. Report of the U. S. Commission of Fish and Fisheries for 1871 and 1872. 1873. (2.) List of the Marine Algae of the United States, with notes of new and imperfectly known species. Proc. Amer. Acad. Vol. X., 1875. (3.) List of the Marine Algae of the United States. Report of the U. S. Fish Commissioner for 1875. 1876. (4.) Marine Algae of New England and adjacent Coast. Report of U. S. Fish Commission for 1879. 1881. (5.) Notes on Arctic Algae; based principally on collections made at Ungava Bay by Mr. L. M. Turner. Proc. Amer. Acad. Vol. XXI, 1886.

Fowler, James. (1.) Report on the Flora of St. Andrews, N. B., Contributions to Canadian Biology, being studies from the Marine Biological Station of Canada. Ottawa, 1901.

Ganong, William Francis. (1.) On Halophytic Colonies in the Interior of New Brunswick. Bulletin of the Natural History Society of New Brunswick, No. 16, 1898.

Hall, Franklin Wilson. (1.) List of the Marine Algae growing in Long Island Sound, within 20 miles of New Haven. Bull. Torr. Bot. Club, Vol. VI, 1876.

Harvey, William Henry. (1.) Nereis Boreali-Americana. Part III. Chlorospermeae. Smithsonian Contributions to Knowledge. Washington. 1858. (2.) Notice of a collection of Algae made on the Northwest Coast of North America, chiefly at Vancouver's Island, by David Lyall, Esq., M. D., R. N., in the years 1859–1861. Proc. Linn. Soc. Botany, Vol. VI, 1862.

Harvey, William Henry, & Bailey, Jacob Whitman. (1.) Algae of the Wilkes Exploring Expedition. Philadelphia, 1872.

Hay, George Upham (1.) Preliminary List of the New Brunswick Algae. Bull. Nat. Hist. Soc. New Brunswick, No. 5, 1886.

Hay, George Upham & MacKay, Alexander Howard. (1.) Marine Algae of the Maritime Provinces. Bull. Nat. Hist. Soc. N. B., 1887.

Hervey, Alpheus Baker. (1.) Sea Mosses. A Collector's

Guide and an Introduction to the Study of Marine Algae. Boston, 1881.

Hooper, John. (1.) Introduction to Algology with a Catalogue of American Algae or Sea-Weeds, according to the Latest Classification of Prof. Harvey. Brooklyn, New York, 1850.

Howe, Marshall Avery. (1.) A month on the shores of Monterey Bay, Erythea, Vol. I. 1893.

Kemp, Alexander F. (1.) A Classified List of the Marine Algae from the Lower St. Lawrence. Canadian Naturalist, Vol. V, 1860.

Kjellman, Frans Reinhold (1.) The Algae of the Arctic Sea. Kongl. Svenska Vetenskaps-Akademiens Handlingar. Bandet. 20, No. 5, Stockholm, 1883. (2.) Om Beringhafvets Algflora. Kongl. Svenska Vet.-Akad. Handl. Bandet 23, 1889.

Martindale, Isaac C. (1.) Marine Algae of the New Jersey Coast and adjacent Waters of Staten Island. Mem. Torr. Bot. Club, Vol. I, 1889.

McClatchie, Alfred James. (1.) Seedless Plants of Southern California. Proceedings of the Southern California Academy of Science, Vol. I. Los Angeles, 1897.

Melvill, James Cosmo. (1.) Notes on the Marine Algae of South Carolina and Florida. Jour. of Bot. Vol. XIII, 1875.

Murray, George. (1.) Catalogue of the Marine Algae of the West Indian Region. Jour. of Bot. Vol. XXVII. 1889.

Olney, Stephen Thayer. (1.) Algae Rhodiaceae. Providence, 1871.

Packard, Alpheus Spring, Jr. (1.) The Sea-Weeds of Salt Lake. American Naturalist, Vol. XIII, 1879.

Pike, Nicolas. (1.) Check List of Marine Algae, Based on Specimens collected on the Shores of Long Island, from 1839 to 1885. Bull. Torr. Bot. Club, Vol. XIII, 1886.

Postels, Alexander & Ruprecht, Franz Joseph. (1.) Illustrationes Algarum Oceani Pacifici, imprimis septentrionalis. Petropoli, 1840.

Robinson, John. (1.) The Flora of Essex County, Massachusetts. Salem, 1880.

Rosenvinge, Lauritz Kolderup. (1.) Grønlands Havalger. Meddelelser om Grønland. Kjobehavn, 1893. (2.) Les Algues Marines de Groenland. Ann. Sci. Nat. Bot. Ser. 7, Vol. XIX, 1894. (3.) Deuxième Mémoire sur les Algues Marines de Groenland. 1898.

Saunders, De Alton. (1.) Papers from the Harriman Alaska Expedition, XXV. The Algae. Proc. Washington Acad. Sci. Vol. III, 1901.

Setchell, William Albert. (1.) Algae of the Pribilof Islands. 1899.

Wolle, Francis. (1.) Fresh-Water Algae of the United States. Bethlehem, Pa. 1887.

Wood, Horatio Curtis. (1.) A Contribution to the History of the Fresh-Water Algae of North America. Smithsonian Contributions to Knowledge. 1872.

ULVACEAE.

Frond consisting of a membrane of one or two layers of cells; in the simplest forms of merely two rows of cells, side by side; or in some parts of the frond of only a single series of cells. Membrane forming a tube or sac, or a flat expansion; simple or branching. Near the base of the frond the cells send down rhizoidal prolongations to the substratum, often uniting to form a thickened stipe; otherwise than this there is no specialization of cells. Asexual propagation by oval zoospores with four cilia, which may be formed in any ordinary cell of the frond, by successive division. Fructification by zoospores similar to the asexual, but noticeably smaller, and with two cilia; after the union of two such zoospores, with no apparent distinction of sexes, a new plant immediately begins to develop.

Of world-wide distribution; the plants usually gregarious, often growing in great quantities. They are specially plants of the litoral zone, occasionally extending down for a short distance in the sublitoral.

KEY TO THE GENERA.

- | | |
|---|---------------|
| Frond membranaceous, of two layers of cells | ULVA. |
| Frond originally tubular, sooner or later opening at the top, and usually dividing into a membrane of a single layer of cells | MONOSTROMA. |
| Frond tubular, or ruptured only by external causes; membrane parenchymatous | ENTEROMORPHA. |
| Frond tubular, very gelatinous, the cells in distinct longitudinal series, which are only loosely connected with each other | ILEA. |

ULVA L.

Frond membranaceous, flat, consisting of two layers of cells, in any of which, excepting those in the thickened base, zoospores may be formed, issuing through an opening in the surface of the frond.

The genus is taken here in the restricted sense, including only the species having fronds always flat; those with tubular fronds, sometimes included in it, now forming the genus *Enteromorpha*. About six species can be considered as well established, though a number of others have been described, some of which must be considered as forms or varieties, and others are insufficiently known. *U. Lactuca* is cosmopolitan; *U. fasciata* is found in nearly all warm seas; *U. Californica* is known from only one station.

KEY TO THE SPECIES.

Fronds minute, triangular or reniform, with distinct stipe	2. <i>U. CALIFORNICA</i> .
Fronds ample, undivided or irregularly lobed	1. <i>U. LACTUCA</i> .
Fronds divided into linear segments	3. <i>U. FASCIATA</i> .

1. *U. LACTUCA* L. Sp. Pl., 1163, 1753. Frond very variable in shape, at first attached and generally of a lanceolate or ovate lanceolate form; later of irregular shape, and often detached and floating. The cells usually vertically elongate in cross section (see Plate 41, fig. 1); seen from the surface, irregularly angular, closely set; thickness of frond very variable.

A very common plant over the whole world, and extremely variable in form, thickness and color. Two fairly marked types can be distinguished in the species as found with us on both Atlantic and Pacific coasts, connected by innumerable forms. Farlow (2) 379; (3) 713; (4) 42, Pl. III, fig. 1. Hay (1) 33. Hay & MacKay (1) 63. Collins (3) 310; (6) 77; (7) 246; (8) 45. Dame & Collins (1) 157; Bennett (1) 95. Martindale (1) 92. Britton (1) 400. Anderson (1) 218. Rosenvinge (1) 939; (2) 145; (3) 116. McClatchie (1) 351. *U. Lactuca* var. *Lactuca* Farlow (4) 43. Hay & MacKay (1) 63. Martindale (1) 92. Britton (1) 400. Collins (7) 246. *U. latissima* Curtis (1) 156. Harvey (1) 59; (2) 176. Kemp (1) 41. Harvey & Bailey (1) 163. Ashmead (2) 96. Olney (1) 42. Eaton (1) 348; (2) 5. Farlow (1) 292; (2) 379; (3) 712. Robinson (1) 166. Anderson (1) 218. Fowler (1) 48.

Var. *RIGIDA*. (Ag.) Le Jolis, Alg. Mar. de Cherbourg, 38, 1863. Frond at first lanceolate or ovate lanceolate, firm and stiff, with a distinct stipe; later somewhat irregularly divided, and often with numerous perforations of various sizes; cells vertically elongate in cross section. Plate 41, fig. 1. cross section.

This is a common form of exposed shores, but occurs also sometimes in quieter waters. In its earlier stage it is distinctly lanceolate in outline, but this form is afterwards lost by irregular growth. It is firm in texture, the color growing deeper as the plant grows older, finally becoming brownish or blackish; the cells have their greatest length at right angles to the surface of the frond, being sometimes three times as long as wide. Farlow (4) 42. Hay & MacKay (1)

63. Bennett (1) 95. Martindale (1) 92. Collins (7) 246; (8) 45. *U. rigida* Harvey (2) 176. Murray (1) 260. Britton (1) 400. Saunders (1) 410. EXSICC. Amer. Algae, 124, 260; Phyc. Bor.-Am., 407.

Var. LATISSIMA (L.) DC., Fl. Fr., Vol. I, 9, 1805. Frond irregular in outline, soon becoming detached and passing most of its life in a floating condition; thinner than var. *rigida*, lighter colored, and with cells nearer square in cross section.

This is a common form of creeks and lagoons, where it forms floating sheets, often of several square meters in extent. It is doubtful if this variety corresponds with the *U. latissima* of Agardh; more probably both the varieties here given are included in the various forms given by him under *U. rigida*; his *U. latissima* is given as occurring only in the German Ocean and the Baltic, and, with some doubt, on the French coast and in the Mediterranean. It is not easy to find from his description just what the difference is between his *U. latissima* and his *U. rigida* "formae b, substantia tenuiores exsiccatione membranaceae." Collins (6) 77. Bennett (1) 95. Britton (1) 400. Martindale (1) 92.

Var. MESENERIFORMIS (Roth) Collins (8) 45; *U. mesenteriformis* J. G. Agardh, Till Alg. Syst. part 3, 163, 1882; De Toni, Syll. Alg., Vol. I, 103, 1889. Frond much contorted and bullate, forming crumpled masses, lying loose on the bottom.

This form is strikingly distinct in appearance, forming much crisped and wrinkled masses, usually of a dark green color, lying on the bottom in creeks and quiet bays. It is so twisted and grown together that only by tearing can even a small piece of it be spread out flat. In cross section the cells are nearer square than those of the type. It is common in marshy ponds near Bridgeport, Conn., and will probably be found in similar places. Known elsewhere only in the Baltic.

2. *U. CALIFORNICA* Wille. Frond 1.5 to 2 cm. long, up to 1.5 cm. wide, triangular or reniform with wavy edge, sometimes with proliferations of a few cells each; passing quickly into a flattened tapering stipe. The cells of the stipe, which on the inner side of each layer form rhizoidal prolongations, are in cross section about quadrate, or a little longer tangentially. The cells in the upper part of the frond are, seen superficially, nearly isodiametric, somewhat irregular in form, with rounded corners; longer and shorter cells alternate, but the longitudinal series are quite inconspicuous. The upper part of the frond is about .03 mm. in thickness.

A species with minute fronds, with more definite outline than is usual in species of this genus. It is known only from Pacific Beach, San Diego County, California, where it is reported by Mrs. E. Snyder as forming a rather dense coating on rocks near high water mark. EXSICC. Phyc. Bor.-Am., 611.

3. *U. FASCIATA* Delile, Egypt, 153, Pl. LVIII, fig. 5, 1813; J. G. Agardh, Till Alg. Syst., part 3, 173, 1882; De Toni, Syll. Alg. Vol. I, 114, 1889. Frond divided into linear segments, margin smooth or undulate; in cross section the two layers of cells separate somewhat at the margin, which is rounded, with a small open space between the rows.

The structure of the frond in this species is similar to that of *U. Lactuca*, except the margin, which resembles *Enteromorpha Linza*; but the shape of the frond with definite linear divisions is quite distinct. These divisions may be dichotomous or apparently lateral; their width may vary from 5 mm. to 5 cm.; and the frond may reach a length of a meter; the margin may be quite smooth and even, or much crisped and undulate; in this it corresponds to forms of *Enteromorpha Linza*. Found on the east coast at Florida, and on the west coast along the whole of California: in warm waters all over the world. Harvey (1) 58; (2) 176. Farlow (2) 379; (3) 713. Harvey (1) 54. Anderson (1) 218. Exsicc. Phyc. Bor.-Am., 221.

Three forms of this species have been distinguished on the Pacific coast, passing into each other more or less.

Forma *TAENIATA* Setchell, Phyc. Bor.-Am., 862. Lobes slender and elongated, crisped and ruffled; prominent teeth on the margins near the base of the frond.

Forma *LOBATA* Setchell, Phyc. Bor.-Am., 863. Lobes shorter and broader, seldom crisped or ruffled.

Forma *CAESPITOSA* Setchell, Phyc. Bor.-Am., 809. Divisions numerous, irregular; fronds intricately entangled, forming a dense coating on the rocks.

MONOSTROMA Thuret.

Frond at first a closed tube or sac, which later opens or splits, forming a membranous expansion, of a single layer of cells, except at the base, where it is thickened, and may consist of several layers of elongated cells. Zoospores formed in any of the cells of the monostromatic part, issuing through an opening at the surface of the frond.

In some of the species of this genus the saccate form has not been observed, but it probably occurs in all. Its persistence varies much, from *M. latissimum*, in which the frond forms a flat expansion when only two or three mm. high, to *M. Groenlandicum*, in which the greater part of the frond continues tubular through its whole life, only the upper part opening at the time of the formation of the zoospores. Some of the smaller species do not exceed 1 dm. in length; others, like *M. Blyttii*, may reach 5 dm. It has representatives in all oceans, and several species inhabit by preference brackish water;

one species lives in fresh water exclusively, and some of the marine and brackish species occasionally occur also in fresh water.

About 30 species have been described, but the differences between some of them seem to be largely due to the age of the specimen or to local conditions; the following arrangement is based chiefly on Rosenvinge's work on the algae of Greenland, where this genus is given a careful study, based on an ample supply of living plants.

KEY TO THE SPECIES.

- | | |
|--|--|
| 1. Frond always tubular | 2 |
| 1. " tubular only in early stage of growth | 3 |
| 2. Tube filiform | 10. <i>M. GROENLANDICUM</i> |
| 2. " intestine-like, collapsing | 3a. <i>M. ARTICUM</i> var. <i>INTESTINIFORME</i> |
| 3. Frond in the full-grown plant with a long, slender stipe; membrane not over 10 μ thick | 6. <i>M. LEPTODERUM</i> |
| 3. Frond never distinctly stipitate | 4 |
| 4. Frond saccate for a considerable part of the growth of the plant; then splitting part of or all the way to the base | 2. <i>M. GREVILLEI</i> |
| 4. Frond saccate only in the very early stages or not at all | 5 |
| 5. Frond dark or dull green, not gelatinous nor adhering to paper. | 1. <i>M. FUSCUM</i> |
| 5. Frond light or bright green, more or less gelatinous, adhering to paper | 6 |
| 6. Mature frond divided into distinct segments | 7 |
| 6. Frond from broadly lanceolate to orbicular; not divided into segments | 8 |
| 7. Segments linear or lanceolate; frond about 6 μ thick above | 4. <i>M. PULCHRUM</i> |
| 7. " few, broad, of no fixed form; frond 25-45 μ thick; cells closely set | 3. <i>M. ARCTICUM</i> |
| 7. Segments obovate, frond 18-36 μ thick; cells not closely set | 7. <i>M. CREPIDINUM</i> |
| 8. Frond not over 30 μ thick | 9 |
| 8. " 40-50 μ thick | 5. <i>M. UNDULATUM</i> |
| 9. Frond usually not much plicate | 10 |
| 9. " " much plicate | 5a. <i>M. UNDULATUM</i> var. <i>FARLOWII</i> |
| 10. Cells arranged in distinct groups of 4 | 9. <i>M. QUATERNARIUM</i> |
| 10. " without order, or indistinctly in groups of 2, 3, or 4 | 8. <i>M. LATISSIMUM</i> |

1. *M. FUSCUM* (Post. & Rupr.) Wittr., Monogr., 53, Pl. IV, fig. 13, 1866; J. G. Agardh, Till Alg. Syst., part 3, 113, 1882; DeToni, Syll. Alg., Vol. I, 109, 1889.

Frond membranaceous, at first tubular, soon splitting, dull or dark green, more or less lobed but not divided to the base; membrane 20-70 μ thick; cells 4-6 angled, very closely set; in cross section from square to vertically elongate, with only slightly rounded corners; occupying nearly the entire thickness of the membrane.

Under this species are included three which were formerly, and by some are still kept distinct; *M. fuscum* with frond of dull color, 20-35 μ thick and cells quadrate in cross section; *M. Blyttii* with deep green frond, blackish in drying, 60-70 μ thick and cells "pal-

isade form" in cross section; and *M. splendens* with deep green glossy frond, 50–55 μ thick, more deeply parted than the others, with cells similar to *M. Blyttii* or more rounded. These three forms pass into each other with no dividing line, while they are sharply marked off from all other species of the genus in nearly every respect. The very young plant is in the form of a closed tube, which soon splits down one side, and spreads out to form a flat membrane; not splitting into several segments, as in the *M. Grevillei* group.

Forma BLYTTII (*M. Blyttii*, Wittr., Monogr., 49, Pl. III, fig. 11, 1866) is common from Nahant northward and has been found at Newport, R. I., by Mrs. Simmons; it grows in tide pools, and also on pebbles in the sublitoral zone; at Revere Beach, Mass., great quantities are sometimes washed ashore by November storms, the stones on which they grew remaining attached to them. In Greenland it is reported as found from Jan. to March, and from May to Sept.; very young plants being found in June. On the Massachusetts coast it makes its appearance in Sept., and reaches its full development in Nov. and Dec. The thinner form which apparently should be considered the typical *M. fuscum* appears to be less common, but is found at Greenland and in Alaska. Plate 41, fig. 2, cross section; fig. 3, surface.

Forma SPLENDENS (*M. splendens* Wittr., Monogr., 50, Pl. III, fig. 12, 1866) occurs in the northern Pacific, in Bering Sea and vicinity, passing into forma *Blyttii*, which occurs nearly typical at Victoria, B. C., and in Washington.

In one form or another the species probably occurs throughout the Arctic Ocean. Kjellman (1) 299; (2) 54. Rosenvinge (1) 940, figs. 47–48; (2) 145, figs. 47–48; (3) 116. Collins (8) 44. Saunders (1) 409. *M. Blyttii* Farlow (4) 41; (5) 477. Collins (1) 70. Britton (1) 400. *M. splendens* Kjellman (2) 54. Setchell (1) 591. EXSICC. Phyc. bor.-Am., 715, 911; Alg. Am.-Bor., 98.

2. *M. GREVILLEI* (Thuret) Wittr., Monogr., 57, Pl. IV, fig. 14, 1866; J. G. Agardh, Till Alg. Syst., part 3, 101, 1882; De Toni, Syll. Alg., Vol. I, 103, 1889. Frond attached, at first saccate, then opening at the top, and ultimately splitting to the base; soft and delicate, pale green; membrane 15–20 μ thick, cells quadrate with rounded angles, closely set; in cross section horizontally oval, 12–14 μ high. Plate 41, fig. 4, cross section; fig. 5, surface.

The saccate form is plain in young plants, and may persist for some time when growing in still water; but at exposed points the frond is soon torn open, and in mature plants all trace of the original shape is lost, wherever growing. According to Rosenvinge, Grønlands Havalger, p. 948, the specimens from Greenland referred to *M. lubricum* Kjellman, in Algae Arctic Sea, p. 295, are *M. Grevillei*. *M. crassiusculum* Kjellman, Om Beringhafvets Algflora, p. 53, Pl. VII, figs. 13–15, seems from the description and figures to be hardly

distinct from *M. Grevillei*, or at most a variety characterized by the slightly thicker frond, with cells occupying considerably less than half the thickness of the frond in cross section. The species is common all along the Atlantic coast from Greenland (March to August) at least as far south as New Jersey (spring months), and has been found on the Pacific coast from Monterey to Alaska. It occurs throughout northern Europe. Farlow (4) 41. Pike (1) 106. Dame & Collins (1) 157. Martindale (1) 92. Rosenvinge (1) 946, fig. 50; (2) 149, fig. 50; (3) 117. Collins (8) 44. *Ulva Lactuca* Harvey (1) 60. Robinson (1) 166. Hervey (1) 54. EXSICC. Phyc Bor.-Am., 15.

Var. VAHLII (J. Ag.) Rosenvinge (1) 949; *M. VahlII* J. G. Agardh, Till Alg. Syst., part 3, 109, Pl. III, figs. 84-89, 1882; De Toni, Syll. Alg., Vol. I, 106, 1889. Slenderer in form, often cylindrical, retaining its saccate shape longer, and with cells arranged in more or less distinct longitudinal series. Otherwise like the type. It occurs in Greenland and in Alaska, and has been found in the Mystic River marshes at Medford, Mass. At the Medford locality it was already formed when the ice broke up in the spring, and quite disappeared in April. It occurred in a ditch where the water remained with little change of level from tides; the conditions were changed by "improvements" several years ago, since which time the plant has not been seen. Rosenvinge (1) 949; (2) 151. *M. VahlII* Dame & Collins (1) 157. Collins (4) 346; (8) 44. Saunders (1) 410.

3. *M. ARCTICUM* Wittr. Monogr., 44, Pl. II, fig. 8, 1866; J. G. Agardh, Till Alg. Syst., part 3. 106, 1882; De Toni, Syll. Alg., Vol. I, 105, 1889.

Frond attached, at first saccate, soon splitting into a few broad laciniae; subradiately plicate, with crisped margin; pale green, becoming yellowish in drying; membrane 25-45 μ thick; cells 4-6 angled, closely set, irregularly placed; in cross section either horizontally or vertically oval, 10-30 μ high. Plate 41, fig. 6, cross section: fig. 7, surface.

A northern species, chiefly distinguished from *M. Grevillei* by the thicker frond, which is saccate only in the earliest stages, and afterwards appears as a rather broad membrane, not split up into narrow strips as is usual in *M. Grevillei*. Rosenvinge, who was familiar with it in Greenland, unites with this species three others, *M. saccodeum* Kjellm.; *M. cylindraceum* Kjellm.; and *M. angicavum* Kjellm.; and then reduces the whole to var. *arctica* of *M. Grevillei*. He says that it is impossible to draw the line between the forms with a thickness of 25 μ and those reaching 60 μ ; or between those with cells in cross section horizontally oval and those vertically oval. In forms so closely related and passing into each other so much as do the forms of *Monostroma*, it is more a matter of personal pref-

erence or of convenience than anything else, whether the forms are distinguished as marked varieties or nearly allied species; the seven forms united by Rosenvinge are here divided into two groups, one included as varieties under *M. Grevillei*, the other as *M. arcticum*; it seems more convenient to keep apart forms such as *M. angicavum* with very thick membrane and large, vertically elongate cells, and the thin membraned typical *M. Grevillei*, with small, horizontally elongate cells. All the forms mentioned are found in Greenland, but are not recorded farther south on this coast; they occur also in northern Norway; the type is found in Alaska. Kjellman (1) 299. *M. Grevillei* var. *arctica* Rosenvinge (1) 949, fig. 51; (2) 152, fig. 51. *M. saccodeum* Kjellman (1) 296, Pl. XXVIII, figs. 1-10. *M. cylindraceum* Kjellman (1) 295, Pl. XXX. *M. angicavum* Kjellman (1) 297, Pl. XXIX. EXSICC. Phyc. Bor.-Am., 910.

Var. *INTESTINIFORME* Rosenv. (1) 153, 1893. Frond tubular, up to 50 cm. long; membrane 25-50 μ thick; cells rounded, closely set, vertically oval in cross section, 15-20 μ high; usually arranged in more or less distinct series longitudinally.

This variety resembles in habit *M. Grevillei* var. *VahlII*, but is more persistently tubular, and except by careful examination of its structure, is liable to be mistaken for *Enteromorpha intestinalis*. It is found in Greenland. Rosenvinge (1) 953, fig. 52; (2) 153, fig. 52.

4. *M. PULCHRUM* Farlow (4) 41, 1881; J. G. Agardh, Till Alg. Syst., part 3, 104, 1882; De Toni, Syll. Alg., Vol. I, 110, 1889. Frond dividing into linear or lanceolate segments with slender base, much crisped at the margin, light green, membrane about 6 μ thick in upper part, up to 15 μ near base, cells roundish, rather irregular in form. Plate 41, fig. 8, cross section; fig. 9, surface.

A beautiful species, extremely delicate, adhering so closely to paper when mounted that it is almost impossible to detach it for examination. It occurs on rocky shores, usually epiphytic on other algae, and is found from April to June on the New England coast, where it occurs as far south as Newport, Rhode Island, and north to Newfoundland.

Foslie and Rosenvinge include *M. pulchrum* under *M. undulatum*, as var. *Farlowii*, Foslie; but this is probably incorrect. It may be that specimens of the latter variety have been distributed under the name of *M. pulchrum*, as there is some external resemblance between them. The latter is, however, more delicate and is usually divided so as to resemble a tuft of fronds of *Euteromorpha Linza*, with narrow tips, the edges much crisped and wavy; while the former has a generally rounded and fan-like outline, the plications long and radiating from the base to the margin. Both, however, vary considerably, and forms can be found which it would be hard to distinguish by external characters. Even if we accept the statement of J. G.

Agardh that the *Ulva Lactuca* of Linnaeus and his immediate successors was a *Monostroma*, with delicate and much divided frond; and that it is the plant distributed as No. 121 of Areschoug, Alg. Scand. Exsicc.; it still remains unlikely that Farlow's *M. pulchrum* is the same plant, as suggested by Agardh. Both Areschoug's plant and a specimen of *M. Grevillei* forma *Lactuca* from Flensburg, determined by Hauck, are relatively coarse plants beside *M. pulchrum*. To appreciate the extreme delicacy of typical forms of the latter, one must have collected it; it requires as careful handling as the tenderest *Callithamnion*. Reinbold, Chlorophyceen der Kieler Fohrde, p. 124, says of *M. Lactuca*, comparing it with *M. Grevillei*, "Thallus rigider, nicht so schlüpfrig," which is by no means the case with *M. pulchrum*. In structure the European specimens referred to come quite near to *M. Grevillei*, but not to *M. pulchrum*. While it is probable that this species is saccate in its early stages, I know of no observation of such a state. Farlow (4) 41. Bennett (1) 95. Collins (8) 44. EXSICC. Phyc. Bor.-Am., 658. Alg. Am.-Bor., 217.

5. *M. UNDULATUM*, Wittr. Monogr., 47, Pl. III, fig. 9, 1866; De Toni, Syll. Alg., Vol. I., 105, 1889. Frond membranaceous, soft and flaccid, with strongly undulate margin; 40–50 μ thick; cells angular, closely set, showing somewhat of an arrangement in twos, threes, and fours; in cross section about 20 μ high, semicircular or oval; the chromatophor not occupying the full height of the cell; not over 10 μ in the middle. Plate 41, fig. 12, cross section; fig. 13, surface.

The typical form, described from Norway, has been found once in Greenland by Rosenvinge; the frond is thicker than in any other species but *M. fuscum*, which is not liable to be mistaken for it, being amply distinct by its color and consistency. Kjellman (1) 295. Rosenvinge (1) 945; (2) 149; (3) 117.

Var. *FARLOWII* Foslie, Contrib. I, 114, 1891, excl. syn. Frond similar to the type, but less than 30 μ thick.

Foslie and Rosenvinge consider this as identical with *M. pulchrum* Farlow; but this appears to be a misapprehension, the latter being much thinner, with more slender and pointed segments or fronds. Greenland, Rosenvinge; Newfoundland, Holden; Marblehead, Collins. Found also in northern Norway. Rosenvinge (1) 945; (2) 149; both excl. syn. Collins (8) 44. EXSICC. Phyc. Bor.-Am., 406.

6. *M. LEPTODERMUM* Kjellm., Algenv. Murmanschen Meeres, 52, Pl. I, figs. 23–24, 1874; De Toni, Syll. Alg., Vol. I, 109, 1889. Frond cuneate-obovate, passing by a narrow base into a tubular, filiform stipe; the flat part of the frond usually entire, with a more or less undulate margin; often twisted below. Cells in the tubular part arranged in longitudinal series, closely set, angular; in flat part similar but smaller; membrane 7–10 μ thick, cells in cross section quadrate or rectangular, 5–8 μ high. Plate 41, fig. 10, cross section; fig. 11, surface.

This species has the most delicate frond of all in the genus, except *M. pulchrum*. It is found in Greenland in many places, growing below low water mark or in pools. It occurs also in Nova Zembla. In young plants the filiform stipe is short and inconspicuous; it appears to continue growing during the life of the plant, reaching a length of two or three cm. Plants collected by the writer at Nahant in June, 1882, and at Cohasset, Mass., in April, 1883, have the membranous part of the frond the same as in Greenland specimens; the stipe, however, is quite inconspicuous. They would seem to belong to this species, possibly imperfectly developed from being so far south of its ordinary range. Apart from the stipe, the chief characters are the thinness of the frond, approached only by *M. pulchrum*; and the squarish cells, regularly arranged, almost like a *Prasiola*. *M. zostericolum* Tilden, American Algae, No. 388, seems to be identical with the plant from Cohasset. As Rosenvinge notes that young plants with very short stipe grew in company with older, long-stiped individuals, it would seem better to include all the forms in question under *M. leptodermum*, without distinction, even as form. Rosenvinge (1) 944, fig. 49; (2) 149, fig. 49; (3) 117. Collins (8) 44.

7. *M. CREPIDINUM* Farlow (1) 14, 1881; J. G. Agardh, Till Alg. Syst., part 3, 101, 1882; De Toni, Syll. Alg., Vol. I., 103, 1889. Frond delicate, light green, 5-15 cm. long, flabellately orbiculate, when fully developed split nearly or quite to the base, segments obovate; membrane 18-36, rarely 45 μ thick; cells roundish-angular, when actively dividing forming compact groups of 2, 3, or 4, separated by rather wide spaces. Plate 41, fig. 14, cross section; fig. 15, surface.

One of the smaller species of the genus, confined to the Atlantic Coast of the United States, on which it is rather common from Cape Cod to New Jersey, and found also at Salem harbor, Mass. A favorite habitat seems to be on woodwork between tide marks, but it also grows on rocks; it is usually in rather dense tufts, which have a rich dark green color, though the individual frond is light green. It is found in spring and summer. The form varies from a flat, roundish, undivided frond, slightly lobed at the margin, to a frond cut nearly to the base into several segments, and radially much plicate. Under the microscope, there usually appear several quite distinct starch granules in each cell. Farlow (4) 42. Collins (1) 70; (3) 310; (6) 77; (8) 44. Martindale (1) 92. Britton (1) 400. EXSICC. Phyc. Bor.-Am., 229. Alg. Am.-Bor., 174.

8. *M. LATISSIMUM* (Kütz.) Wittr., Monogr., 33, Pl. I, fig. 4, 1866. J. G. Agardh., Till Alg. Syst., part 3, 99, 1882; De Toni, Syll. Alg., Vol. I, 102, 1889. Frond at first attached, afterwards floating, thin and soft, glossy, of irregular shape, more or less plicate near the even or undulate margin; membrane 20-25 μ thick, cells 4-6 cornered or roundish, closely set, without order or more or less distinctly in twos, threes or fours; in cross section vertically oval or

nearly circular, 14–18 μ high. Plate 41, fig. 18, cross section; fig. 19, surface.

Apparently not uncommon in quiet waters, especially in ditches in marshes, where the water is sometimes brackish rather than salt. At first it is attached to various objects, but soon becomes loosened and floats freely, sometimes in such abundance as to quite fill a ditch from bottom to surface. It appears in spring, and continues, chiefly in the floating state, through the summer. The color is a quite rich green in the young plant, usually paler in the older, floating individuals. The arrangement of cells varies in plants from the same locality, and even in different parts of the same frond; in some cases the arrangement of cells in twos and fours is very like *M. quaternarium* but the New England plant probably is all *M. latissimum*. The cells are usually said to be vertically elongate in cross section; but this is true only in a general way, as individual cells, and sometimes a considerable proportion of the whole, have their longer axes parallel to the surface of the frond; indeed, the shape of the cells, whether seen from above or in cross section, is liable to vary in any species of *Monostroma*, or in different stages of growth of the individual. From Maine to Florida; Washington and Alaska; shores of Europe, Africa, New Zealand. Dame & Collins (1) 158. Collins (4) 341; (8) 44. EXSICC. Phyc. Bor.-Am., 14.

9. *M. QUATERNARIUM* (Kütz.) Desmaz., *Plantes Crypt. de France*, Nouvelle Série, 603; Wittr., *Monogr.*, 37, 1866; J. G. Agardh, *Till Alg. Syst.*, part 3, 98, 1882; De Toni, *Syll. Alg.*, Vol. I, 100, 1889. Frond at first attached, soon becoming free, soft and delicate, irregularly lobed and folded, 20–23 μ thick; cells rounded, when actively dividing set closely in threes and fours within the mother cell wall; in cross section semicircular or oval, 15–17 μ high. Plate 41, fig. 16, cross section; fig. 17, surface.

As was noted under *M. latissimum*, that species is very near *M. quaternarium*, and as far as New England specimens are concerned, it is impossible to draw the line. Specimens from California, however, all as far as seen distinctly show the arrangement in threes and fours, and more plainly than do any eastern specimens.

Besides occurring in salt water at Santa Cruz, California, it is found in quite fresh water in the interior of the state, at Santee, by Miss Minnie Reed, and was collected by Dr. Sereno Watson at 2000 meters elevation in the Diamond mountains, Nevada. It occurs in various parts of Europe. I am indebted to Dr. George T. Moore of the U. S. Department of Agriculture for the opportunity to examine an authentic specimen of *Ulva merismopedioides* Wood, collected by Dr. Watson in connection with the U. S. Geological Exploration of the Fortieth Parallel. It is undoubtedly *M. quaternarium*, and as the cells are actively dividing, the quaternate character is very marked. Anderson (1) 218. *Ulva merismopedioides*, Wood (1) 182. EXSICC. Phyc. Bor.-Am., 567.

10. *M. GROENLANDICUM* J. G. Agardh, Till Alg. Syst., Part 3, 107, Pl. III, Figs. 80-83, 1882; De Toni, Syll. Alg., Vol. I, 106, 1889.

Frond filiform, tubular, cylindrical, up to 15 cm. long, from a very slender base expanding to 1 mm. diameter; apex broken only after exit of zoospores. Cells in the lower part of the frond loosely arranged in twos and fours, roundish angular; in the upper part more evenly distributed, more or less closely set. In cross section the membrane is 25-35 μ thick; the cells radiately elongate, 2-4 times as long as broad; in the younger parts the central cavity is filled with a gelatinous substance, which disappears as the plant becomes older. Zoospores formed first at the summit of the frond, and developing successively in lower cells. Plate 41, fig. 20, cross section; fig 21, surface.

This plant has no external resemblance to a *Monostroma*, and was placed in this genus with a mark of doubt by both Farlow and Rosenvinge. It appears like a slender unbranched *Enteromorpha*, but seems, however, to be in structure more nearly related to *Monostroma*. It has been found at Nahant and Swampscott on the Massachusetts coast; at Newfoundland; at several places in Greenland and in Alaska. It occurs from April to June in New England; in July at Newfoundland; and from May to August in Greenland. At Nahant, it grows in rather dense tufts, at the lower limit of the litoral zone, in company with *Cladophora arcta*, *Bangia fusco-purpurea*, *Urospora penicilliformis*, etc. Rosenvinge (1) 954, fig. 53; (2) 155, fig. 53; (3) 117. Saunders (1) 410. Collins (8) 44. Exsicc. Phyc. Bor.-Am., 13. *M. Collinsii* Alg. Am.-Bor., 216, without description.

ENTEROMORPHA Link.

Frond originating in a single series of cells, which by repeated division form a tubular frond, the membrane of which consists of a single layer of cells; in some of the simpler species the tubular stage is not reached, and the frond in the adult state consists of two or a few series of cells, united without any interior open space. All the cells of the frond, except the lowest, capable of producing zoospores, which are discharged through an opening in the cell wall.

A large genus, at least 50 species having been described, of which a part will probably be united with other species. It is connected with *Ulva* by *E. Linza*, in which the tube is compressed, and the membranes united in the median part; on the other hand, *Monostroma Groenlandicum* is hardly to be distinguished from some of the simple filiform species of *Enteromorpha*. *E. intestinalis* is found the world over, and other species are very widely distributed. They are found not only in the sea, but also about salt springs and salt mines; they abound in brackish, and are occasionally found in quite fresh water.

The specific distinctions are not always clearly marked, but that is to be expected in a genus of this extent, where the characters available for specific distinctions are so few. In the following arrangement J. G. Agardh's classification is pretty nearly followed, and a few more species are recognized than are allowed in Rosenvinge's work. Though perplexing intermediate forms will undoubtedly be found, it is thought that the type of each species will be found fairly distinct.

KEY TO THE SPECIES.

1. Frond flat, the membranes free at the margins but united between
 1. Frond of one to a few series of cells, not tubular
 1. Frond tubular
 2. Frond simple
 7. *E. LINZA* 2
 12. *E. PERCURSA* 3
 2. Frond branched
 14. *E. CRUCIATA* 4
 3. Cells not arranged in longitudinal series except in the very youngest parts
 3. Cells more or less in longitudinal series, usually in the greater part of the frond
 4. Cells of new generation in twos, threes and fours in the wall of the mother cell
 2. *E. FASCIA* 5
 4. Mother cell wall not persisting after division
 19. *E. ACANTHOPHORA* 6
 5. Frond with short, spine-like ramuli, in addition to branches
 5. Frond with more or less plentiful branches
 6. Frond simple or with a few proliferations
 6. Frond with flattened rachis branching from the margin
 - 1 a. *E. MICROCOCCA* var. *SUBSALSA* 7
 6. Frond filiform; branches with contracted base, expanding upwards
 9. *E. COMPRESSA* 8
 7. Cells 10–16 μ in diam.; frond usually inflated and constricted; often of large size
 6. *E. INTESTINALIS* 8
 7. Cells 4–8 μ diam.; fronds usually only 1–5 cm. long
 8. Frond 8–10 μ thick; cells 5–7 μ diam.
 8. *E. MINIMA* 1
 8. Frond 15–20 μ thick; cells 4–5 μ diam.
 1. *E. MICROCOCCA* 3
 9. Frond simple, inflated and flexuous
 3. *E. FLEXUOSA* 10
 9. Frond simple or with occasional proliferations; not inflated
 10. Frond regularly branched
 10. Frond narrowly linear, strongly compressed
 10. *E. MARGINATA* 11
 10. Frond filiform, 2–8 cells wide, tubular only in the widest parts; branches 2 cells wide
 13. *E. TORTA* 4a. *E. PROLIFERA* var. *TUBULOSA* 5a. *E. SALINA* var. *POLYCLADOS* 4. *E. PROLIFERA* 5. *E. SALINA* 12
 10. Frond filiform, tubular, of uniform diameter; of numerous series of squarish cells
 11. Frond beset with numerous short thorn-like branches
 11. Branches proliferous, similar to main filament
 4. *E. PROLIFERA* 13
 11. Branches proliferous, of two or sometimes one series of cells
 12. Chromatophor filling cell
 12. Chromatophor not filling cell, giving a net-like appearance
 14. Ultimate ramuli short, spine-like, not monosiphonous
 18. *E. RAMULOSA* 11. *E. CRINITA* 13
 13. Ultimate ramuli of a single series of cells
 11. *E. CRINITA* 13

13. Ultimate ramuli polysiphonous, of a few, symmetrically placed series of cells
 14. Ultimate ramuli of a single series of cells
 14. Ultimate ramuli not of a single series of cells
16. *E. ERECTA*
 15. *E. HOPKIRKII*
 17. *E. CLATHRATA*

1. *E. MICROCOCCA* Kütz., Tab. Phyc., Vol. VI., 11, Pl. XXX, fig. 2, 1856; J. G. Agardh, Till Alg. Syst., part 3, 123, 1882; De Toni, Syll. Alg., Vol. I., 118, 1889. Fronds 1-5 cm. long, 1-5 mm. wide, tubular or compressed, simple or slightly proliferous, much curled and twisted; cells angular, 4-5 μ diam., in no definite order; thickness of membrane, 15-20 μ . Plate 42, fig. 1, surface; fig. 2, cross section.

The smallness of its cells distinguishes it from all our species but *E. minima*, in which the dimensions are only slightly larger; but the latter has a very thin and delicate membrane, while in *E. micrococca* it is relatively quite thick, the thickening being specially pronounced on the inner side. This gives it a coarser feeling to the touch than has *E. minima*. It is common from Marblehead, Mass., north; its favorite habitat on the New England coast appears to be the surface of shaded steep or vertical cliffs, especially where the flow or drip of fresh water keeps it continually moist; it has been found in Alaska; also on the Atlantic and Mediterranean shores of Europe. Collins (4) 336; (7) 245; (8) 44. Saunders (1) 411. *E. intestinalis* var. *micrococca*, Rosenvinge (1) 957, fig. 54; (7) 157, fig. 54. EXSICC. Phyc. Bor.-Am., 66.

Var. *SUBSALSA* Kjellm. (1) 292, Pl. XXXI, figs. 1-3; De Toni, Syll. Alg., Vol. I, 120, 1889. Rachis flattened, with numerous patent branches from the edges; much twisted and contorted; color, dark green.

Reported by Kjellman from the west coast of Greenland, and from various localities in the European Arctic Sea; Rosenvinge raises some doubt as to the identity of the Greenland plant. Its habitat in the Arctic regions is in lagoons; at Cambridge, Mass., Setchell found what is apparently the same plant, growing in muddy places in Charles River marshes. It also occurs on the west coast at Washington. Collins (8) 44. EXSICC. Phyc. Bor.-Am., 467.

2. *E. FASCIA* Post & Rupr. (1) 21; J. G. Agardh, Till Alg. Syst., part 3, 125, 1882; De Toni, Syll. Alg., Vol. I, 120, 1889. Frond elongate, tubular-compressed, from a slender stipe, sparingly branched; cells 4-6 x 6-8 μ , roundish-angular, in no apparent order, often containing 2-4 daughter cells.

In the form of the frond not unlike *E. intestinalis*, but with a different arrangement of cells, somewhat recalling *Ilea fulvescens*. The latter, however, is much softer and more gelatinous, and the cells are arranged in longitudinal series, and more symmetrical in all respects. The characteristic arrangement of cells is not always distinct, and in its absence this species is not easily distinguished

from *E. intestinalis*. It occurs on both shores of the Bering Sea. Kjellman (2) 52.

3. *E. FLEXUOSA* (Wulf.) J. G. Agardh, Till Alg. Syst., part 3, 126, 1882; De Toni, Syll. Alg., Vol. I, 121, 1889. Frond cylindrical, tubular, simple, tapering to a filiform stipe below, above inflated, flexuous and intestine-like; cells 6–8 x 8–12 μ , roundish polygonal, in longitudinal series; membrane somewhat thickened on the inside; chromatophor filling the thick walled cell. Plate 42, fig. 3, surface.

This is a southern species, and on our Florida shores appears to take the place of *E. intestinalis* in the north. From the latter it differs in having somewhat smaller cells, arranged in regular series; also somewhat more delicate membrane. From *E. compressa* it is also distinguished by the arrangement of the cells, and its habit is dissimilar; from both these species it differs in having a thicker wall between the cells. It seems to be common in Florida, and occurs on the west coast at Santa Barbara and San Diego. Warmer temperate regions of the world. EXSICC., Phyc. Bor.-Am., 462.

4. *E. PROLIFERA* (Fl. Dan.) J. G. Agardh, Till Alg. Syst., part 3, 129, Pl. IV, figs. 103 and 104, 1882; De Toni, Syll. Alg., Vol. I, 122, 1889. Frond up to several meters long, and 2 cm. diameter, tubular or compressed, with more or less abundant proliferous branches, which are usually simple, but sometimes also proliferous; branches varying much in length and diameter; cells 10–12 μ , in the younger parts always arranged in longitudinal series, which become less distinct in the older parts; membrane 15–18 μ thick, not much exceeding the dimensions of the cells in cross section. Plate 42, fig. 5, surface.

A common species, formerly included in *E. compressa* or *E. intestinalis*, to the former of which it is most allied, but from which it differs in the longitudinally seriate cells, very manifest in the younger portions, and disappearing only in the quite old parts. In habit it is very variable, from slender, slightly branched forms, only a few cm. long, to richly and repeatedly branched fronds; branches sometimes long and slender, sometimes short and very densely set, sometimes long and short intermingled quite without order. In one form there is a stout main stem, from which smaller proliferous branches issue at nearly right angles, reminding one of some coniferous trees. It appears to prefer somewhat sheltered localities, where it is not left bare for any considerable time at low tide. It is reported from Greenland, and as far south as New Jersey; as Agardh reports it from the West Indies, it probably occurs along the whole Atlantic coast. It has been found only at Alaska on the west coast, but probably occurs at other localities. It occurs in brackish water in South Dakota, (Saunders) and in fresh or very slightly brackish at Los Angeles, California, (Miss Monks). It is found along all the shores of Europe, and in fresh water in several European countries.¹ Rosen-

¹ *E. LINGULATA* J. G. Agardh, Till Alg. Syst., part 3, 143, 1882. "Tufted, grass-green, delicately membranaceous, tubular, membrane somewhat collapsing in

vinge, (1) 960; (2) 158; (3) 118. Collins (8) 44. Saunders (1) 411. EXSICC. Phyc. Bor.-Am., 610, 913; Amer. Algae, 127, 264, 265 (as *E. compressa*), 128 (as *E. clathrata*), 385.

Var. ARCTICA (J. Ag.) Rosenv. (1) 960; (2) 158. *E. arctica*, J. G. Agardh, Till Alg. Syst., part 3, 124, Pl. IV, figs. 100-102, 1882; De Toni, Syll. Alg., Vol. I, 120, 1889. Cells smaller and rounded, membrane 20-30 μ thick, cells 10-14 μ in cross section, usually longer than broad, sometimes double their breadth. Occurs Greenland to Spitzbergen.

Var. TRABECULATA Rosenv. (1) 961, fig. 55; (2) 159, fig. 55. Slenderer than the type, with long capillary branches; the central cavity traversed by transverse and oblique "trabeculae." Greenland.

Var. TUBULOSA (Kütz.) Reinbold, Chlorophyceen der Kieler Fohrde, 117, 1889; *E. tubulosa*, J. G. Agardh, l. c., 128, 1882; De Toni, l. c., 122, 1889. Slender, slightly branched, of nearly uniform size throughout. In ditches in salt marshes, Revere, Mass.; Great Salt Lake, Utah; Baltic and German Seas. EXSICC. Phyc. Bor.-Am., 471; Amer. Algae, 262.

5. *E. SALINA* Kütz., Phyc. Germ., 247, 1845; De Toni, Syll. Alg., Vol. I, 136, 1889. Frond filiform, tubular, with a few branches, which are sometimes opposite, of two or more rows of cells, or in the youngest of a single series; cells quadrangular, 14-16 μ square, or slightly longer than broad, in longitudinal series throughout; membrane thickened on both sides.

The slender fronds with relatively large cells in longitudinal series distinguish this species with tolerable distinctness from any others within our limits. It was found by De A. Saunders at Lake Pontchartrain in Louisiana, and by Mrs. Curtiss in Florida. Found in the Baltic and near salt mines in the interior of Europe. EXSICC. Phyc. Bor.-Am., 859.

Var. POLYCLADOS Kütz., Phyc. Germ., 246, 1845. Filaments beset with more or less numerous short, horizontal, spine-like ramuli. Occurring in a brackish ditch at Key West, Florida; collected by Farlow.

drying, below densely branched, branches ascending, somewhat dilated from a narrow base, simple, long, apparently lingulate; cells subquadratically rounded, forming longitudinal series through nearly the whole length of the frond; endochrome rounded, occupying nearly the whole space of the cell. Atlantic shores of Europe and America; in the Gulf of Mexico."

The above is translated from the original description; the species does not appear to have been recognized by American algologists. At Marblehead, Mass., a form occurs which agrees very well with the *E. lingulata* of Hauck, in Phycotheca Universalis, No. 14; but Bornet, comparing this with an authentic specimen from Agardh, considers Hauck's plant to belong to a different species. See Bornet, les Algues de P.-K.-A. Schousboe, p. 199. It is possible that Agardh's plant may have been included here in *E. prolifera*; there is no very sharp line drawn in the descriptions.

6. *E. INTESTINALIS* (L.) Link, Epist. in Hor. Phys. Berlin, 5, 1820; J. G. Agardh, Till Alg. Syst., Part 3, 131, Pl. IV, Fig. 109, 1882; De Toni, Syll. Alg., Vol. I. 123, 1889. Frond simple or having at the base a few branches similar to the main frond, or occasionally a few proliferations above; length varying from a few centimeters to several meters; diameter from 1–5 cm.; at first attached by a short cylindrical stipe, but soon detached and floating; cylindrical or expanding above, more or less inflated, often much crisped and contorted, and irregularly and strongly constricted; cells 10–16 μ diam., in no regular order; thickness of membrane varying from 50 μ below to 20 μ above; cells in cross section from 12 to 30 μ . Plate 42, Fig. 6, surface; fig. 7, cross section.

A common and exceedingly variable species, occurring throughout our limits except on the southern Atlantic coast, where *E. flexuosa* appears to take its place. There are many intermediate forms that connect it with *E. compressa*, but in its typical form it is distinguished by the internally thickened membrane, and by the intestinal appearance, which is indicated by both its generic and its specific name. It is especially a plant of quiet waters, where it sometimes attains enormous dimensions. Europe, West Brazil, Indies, Japan. Harvey (1) 57, in part. Eaton (1) 348. Farlow (1) 292; (2) 378; (3) 712. Wood (1) 183. Robinson (1) 166. Hervey (1) 50. Hall (1) 112, in part. Rosenvinge (1) 957; (2) 157; (3) 117. Collins (7) 245; (8) 44. Saunders (1) 411. *Ulva Enteromorpha* var. *intestinalis* Farlow (4) 43. Hay & MacKay (1) 63. Collins (4) 310; (6) 77. Dame & Collins (1) 157. Bennett (1) 95. Martindale (1) 92. Howe (1) 67. EXSICC. Phyc. Bor.-Am., 464. Amer. Algae, 263.

Among the many forms of this species which have been described, the following have been recognized in America.

Forma *CYLINDRACEA* J. G. Agardh, Till Alg. Syst., part 3, 131, 1882. Frond long and slender, of uniform diameter. Newport, R. I., Bridgeport, Conn., floating unattached. Saunders (1) 411. Collins (8) 44. EXSICC. Phyc. Bor.-Am., 465: Amer. Algæ, 126.

Forma *CLAVATA* J. G. Agardh, l. c. 131. Frond attached, clavate, from a filiform stipe, usually more or less contorted. Cutler, Maine; Alaska. EXSICC. Phyc. Bor.-Am., 966.

Forma *MAXIMA* J. G. Agardh, l. c. 132. Frond floating, unattached, inflated and bullate. In quiet waters, Mass., Conn., N. J., Alaska. Saunders (1) 411. Collins (8) 44.

Forma *tenuis* n. f. Membrane thin and delicate, not thickened within. Artesian running water, Redfield, So. Dakota. Amer. Algae, 125. In size and shape of cells and in habit of frond, this form agrees with forma *clavata* of the coast. The difference in the character of the membrane may be due to the peculiar station.

7. *E. LINZA* (L.) J. G. Agardh, Till Alg. Syst., part 3, 134, Pl. IV,

figs. 110-112, 1882; De Toni, Syll. Alg., Vol. I, 124, 1889. Frond lanceolate or linear-lanceolate, simple, 1-5 dm. long, 1-20 cm. broad; stipe short, hollow; upper part of the frond flat, the membranes grown together, as in *Ulva*, except at the edges, where they remain free. Plate 42, fig. 8, cross section of margin.

Forma CRISPATA, edges much crisped and folded.

Forma LANCEOLATA, edges even or plicate, not crisped.

These two forms are taken as defined by Agardh, l. c., and in one form or another this species seems common along the whole Atlantic coast from Maine to Florida, and is reported on the Pacific coast from Bering Straits to Santa Barbara, Cal. It grows on stones, woodwork and other algae, usually in places seldom or never left bare by the tide. The smaller forms look like forms of *E. intestinalis*, but in the latter the frond, though often collapsed, is tubular throughout; in *E. Linza* the two membranes adhere, except at the edges, where there is a narrow open space, around which the cells are arranged, in cross section nearly in a circle. Europe, West Indies, Brazil, Peru, Tasmania. Kjellman (2) 53. Collins (7) 245; (8) 44. Saunders (1) 410. *Ulva Linza* Post. & Rupr. (1) 21. Hooper (1) 30. Harvey (1) 59; (2) 176. Kemp (1) 41. Farlow (1) 292; (2) 379. Hall (1) 112. Anderson (1) 218. Fowler (1) 48. *U. Enteromorpha* var. *lanceolata* Farlow (4) 43. Pike (1) 106. Hay & MacKay (1) 63. Collins (3) 310. Dame & Collins (1) 157. Bennett (1) 95. Britton (1) 400. Martindale (1) 92. *U. latissima* var. *Linza* Harvey (1) 53. EXSICC. Phyc. Bor.-Am., 16, 967; Amer. Algae, 384.

8. *E. MINIMA* Näg. in Kütz., Sp. Alg., 482, 1849; J. G. Agardh, Till Alg. Syst., part 3, 135, 1882. Frond 1-10 cm. long, 1-5 mm. broad, simple or slightly proliferous, soft and delicate, membrane 8-10 μ thick, cells angular, 5-7 μ diam. arranged in no definite order. Plate 42, fig. 9, surface; fig. 10, cross section.

A small species, resembling *E. compressa*, but smaller in dimensions of fronds and size of cells. It is probably common, but is easily overlooked among the larger and better known species of the genus. The extreme thinness of the frond gives it a very soft and delicate feeling to the touch, which is the best character by which to recognize it when growing. It seems to grow mostly in the lower half of the litoral zone. At Southwest Harbor, Mount Desert Island, Maine, it grew in abundance on woodwork of weirs, etc.; at Spectacle Island, Penobscot Bay, on rock; at Bridgeport, Conn., on rocks, *Fucus*, *Spartina*, etc., on a muddy shore; at San Francisco, California, on rocks at high water mark. Found also at Vancouver and Alaska; North Atlantic, Mediterranean, South Pacific. Collins (5) 458; (8) 44. *E. intestinalis* var. *minima* Rosenvinge (1) 959; (2) 159. EXSICC., Phyc. Bor.-Am., 468, 912.

Forma RIVULARIS Collins, has a pale color, fronds half a meter in length, and substance more gelatinous than the type. These differ-

ences are probably all due to its place of growth, — running fresh water, Alaska. Exsicc., Phyc. Bor.-Am., XXVI; Amer. Algae, 261, as *E. micrococca*.

Forma GLACIALIS Kjellman, Algenv. Murm. Meeres, 50, 1877. Frond 9–13 μ thick, cells 5–8 μ diam.: forming a dense coating on rocks covered only at high tide, and at other times wet with water from melting ice. Greenland. Rosenvinge (1) 959; (2) 159.

9. *E. COMPRESSA* (L.) Grev., Algae Brit., 180, Pl. XVIII, 1830, excl. var.; J. G. Agardh, Till Alg. Syst., part 3, 137, 1882; De Toni, Syll. Alg., Vol. I, 126, 1889. Frond tubular, more or less compressed, sometimes constricted, varying much in dimensions, simple or slightly branched; branches usually simple, cylindrical or expanding above, in either case narrowed at the base, similar in appearance to the main frond; cells in no definite order; membrane rather thin. Plate 42, fig. 11, surface; fig. 12, cross section.

A very variable species, but now understood in a narrower sense than formerly, and including only forms with branches contracted at the base and expanded upwards, with cells about 10–15 μ diam., arranged in no definite order and with membrane not thickened. It occurs all along the Atlantic coast, and from Alaska to San Francisco. In New England it appears to be one of the less common species. Europe, Brazil, West Indies, Sandwich Islands, Tasmania. Farlow (1) 292; (2) 378; (3) 712. Robinson (1) 166. Kjellman (2) 52. Collins (1) 245; (8) 44. *Ulva compressa* var. *racemosa* Kjellman (2) 52. *U. Enteromorpha* var. *compressa* Farlow (4) 43. Dame & Collins (1) 157. Collins (6) 77. *Enteromorpha intestinalis* var. *compressa* Rosenvinge (1) 958; (2) 158. Exsicc., Phyc. Bor.-Am., 964.

Forma SUBSIMPLEX J. G. Agardh, Till Alg. Syst., 137, 1882. Frond hardly branched, of uniform diameter. So. Harpswell, Maine. Exsicc., Phyc. Bor.-Am., 964.

10. *E. MARGINATA* J. G. Agardh, Alg. Med., 16, 1842; Till Alg. Syst., part 3, 142, 1882; De Toni, Syll. Alg., Vol. I, 127, 1889.

Frond filiform, compressed, simple or with a few short proliferous branches; cells 4–8 μ diam., squarish, arranged in longitudinal series, very distinctly in the two or three rows at each side, less so in the middle portion. Plate 42, fig. 13, surface.

A small species and apparently not common. It occurs on stems and roots of *Spartina*, etc., at Quincy and Weymouth, Mass., Newport, R. I., Bridgeport, Conn., and Atlantic City, New Jersey. Inland at Great Salt Lake, Utah. The color is usually quite a deep green; the fronds are comparatively narrow, seldom over 15–20 cells wide, and the width continues quite uniform throughout a filament, the margin being straight and even. Usually the fronds are simple, but occasionally one finds a few proliferous branches. Mediterranean. *Ulva marginata* Packard (1) 702. Collins (2) 131; (3)

310; (8) 44. Martindale (1) 93. Britton (1) 400. Exsicc., Amer. Algae, 266; Phyc. Bor.-Am., 466.

11. *E. CRINITA* (Roth) J. G. Agardh, Till Alg. Syst., part 3, 145, 1882; De Toni, Syll. Alg., Vol. I, 129, 1889.

Frond filiform, cylindrical or compressed, much and repeatedly branched, the branches tapering, the smallest usually of a single series of quite short cells; cells almost always in longitudinal series, often rounded, nearly or quite filled by the chromatophor. Plate 42, fig. 14, surface view with monosiphonous branch.

In habit this species is much like *E. clathrata*, especially the var. *prostrata*; but the latter lacks the short-celled monosiphonous ramuli; monosiphonous ramuli are found in *E. Hopkirkii*, but the net-like cells of the latter are quite distinct from the cells of *E. crinita*, which resemble those of *E. prolifera*, though somewhat smaller. Their typical forms are of different habit; intermediate forms are, however, provokingly common. It occurs along the New England coast and from San Francisco, Cal., to Alaska; according to Agardh, in the Gulf of Mexico; it probably extends over the coasts of both sides of the continent; Atlantic shores of Europe; Red Sea. Collins (5) 2; (8) 44. Saunders (1) 412. *E. clathrata* var. *crinita* Martindale (1) 93. Britton (1) 401. Exsicc., Phyc. Bor.-Am., 460, 965.

12. *E. PERCURSA* (Ag.) J. G. Agardh, Alg. Med., 15, 1842; *E. percursa* var. *simpliciuscula*, Till Alg. Syst., part 3, 146, 1882¹; De Toni, Syll. Alg., Vol. I, 146, 1889, in part.

Frond filiform, in the earliest state of one row, afterwards of two rows of cells, placed symmetrically side by side; cells 10–15 μ wide, from once to twice as long. Plate 42, fig. 15, young filament; fig. 16, mature filament.

A common species, forming masses in upper tide pools, and in ditches in marshes, etc. It often grows in company with other species, but is easily distinguished on microscopic examination by the double row of cells, usually in exact symmetry, side by side. The small chromatophors occupy only part of the cell room, giving the same net-like appearance found in *E. clathrata*. It is found from Greenland to New Jersey, and from Alaska to California; it is apparently a summer plant. Europe. Collins (8) 44. *Tetranema percursum* Collins (7) 244. *Percursaria percursa* Rosenvinge (1) 963; (2) 160; (3) 118. *Ulva percursa* Collins (2) 131; (3) 310. Martindale (1) 93. Britton (1) 401. Exsicc. Alg. Am.-Bor., 219; Phyc. Bor.-Am., 469, 968.

13. *E. TORTA* (Mert.) Reinbold, Nuova Notarisia, series 4, 201, 1893. *E. percursa* var. *ramosa* J. G. Agardh, Till Alg. Syst., part 3, 146, 1882.

¹ The *E. percursa* of J. G. Agardh, l. c. 146, appears to include at last two species; for a full discussion of the question see Reinbold, Nuova Notarisia, Series IV, 201, 1893.

Frond filiform, compressed, simple or with occasional long proliferous branches, which usually consist of only two rows of cells; cells rectangular, always in longitudinal and mostly in cross series. Plate 42, fig. 4, surface view.

A very slender species, the main filaments only 2–8 cells wide, and only in the wider forms showing any open space within. The branches are few, at wide angles, and are seldom over two cells wide. They resemble somewhat the fronds of *E. percursa*, but the cells in the latter are more symmetrically arranged; and *E. percursa* is always simple and never has over two rows of cells, as do most of the older parts of this plant. It has been found only once in this country, at Eagle Island, Penobscot Bay, Maine, in a lagoon, where the water is usually more salt than the sea, with which it connects only at very high tides. Here the plant was scattered among *Cladophora expansa*, *Lyngbya aestuarii*, and species of *Enteromorpha*, the whole forming a dense mass covering the water for a considerable area. Europe. Collins (5) 2; (8) 44. EXSICC. Phyc. Bor.-Am., 223.

14. *E. CRUCIATA* Collins (5) 3. Frond filiform, branching, mostly of a single series of cells, but at the points of branching often of two or more series; branches issuing at right angles or nearly so, usually opposite but sometimes alternate or secund, simple, usually short, tapering; monosiphonous portions 20–30 μ diameter; cells about as long as broad, cell wall thick; in the irregular masses, where several branches issue near together, the cells are rounded and sometimes reach a diameter of 50 μ . Plate 43, fig. 1.

This plant is very different from other species of *Enteromorpha*, the nearest being *E. percursa*; but *E. cruciata* has nothing of the symmetry and uniformity that especially characterize *E. percursa*. The monosiphonous parts with few and short branches remind one somewhat of *Rhizoclonium*, but the branches are often of many cells, and wherever several branches issue near the same point, an irregular mass of cells is formed. The chromatophor is roundish, in young plants bright green, in older plants or parts of the plant paler, as in other *Enteromorpha* species; the chromatophor does not fill the cell. It was found in a lagoon at Eagle Island, Penobscot Bay, Maine, in floating masses in company with *Cladophora expansa*, *Lyngbya*, etc., in July, 1894, and is not known elsewhere. Collins (5) 3; (8) 44. EXSICC. Phyc. Bor.-Am., 222.

15. *E. HOPKIRKII* Harvey, Phyc. Brit., Pl. CCLXIII, 1849; J. G. Agardh, Till Alg. Syst., part 3, 151, 1882; *E. plumosa* De Toni, Syll. Alg., Vol. I, 132, 1889. Frond filiform, cylindrical or somewhat compressed, very slender and delicate, much and repeatedly branched, the branches tapering and ending in a single series of cells; cells about 8 μ wide in monosiphonous part, below about $12 \times 20 \mu$, with quite small chromatophor, always in longitudinal and often in cross series. Plate 43, fig. 3.

One of the most attractive of our *Enteromorphas* both in habit and microscopically. There are other species which occasionally have short monosiphonous branches, but in *E. Hopkirkii* nearly every young branch terminates in a monosiphonous series of considerable extent. A form is common in northern New England, growing largely on *Cladophora glaucescens*, and also on rocks and shells, in rock pools. This form is very slender throughout and the cells in the larger filaments have in a marked degree the net-like character found in *E. clathrata*; it seldom exceeds 2 dm. in length. In quiet bays another form occurs, sometimes reaching a length of over a meter; in this form the cells are squarer than in the other, the fronds not so slender; it is common in southern New England. Europe. Harvey (1) 58. Farlow (1) 292. Collins (7) 246; (8) 44. *Ulva Hopkirkii* Farlow (4) 44. Collins (3) 310; (6) 78. Dame & Collins (1) 157. Martindale (1) 93. Britton (1) 401. Hay & MacKay (1) 64. EXSICC. Phyc. Bor.-Am., 463.

16. *E. ERECTA* (Lyng.) J. G. Agardh, Till Alg. Syst., part 3, 152, 1882; De Toni, Syll. Alg., Vol. I, 133, 1889. Frond filiform, with numerous long, usually erect branches, more slender than the main filament; the ultimate ramuli of varying length, polysiphonous, the cells being symmetrically arranged in successive segments, similar to those of *Polysiphonia*; cells in main stem and branches in longitudinal and usually in lateral series. Plate 43, fig. 2.

The most distinctive character of this species is found in the polysiphonous ramuli; in habit it is not unlike *E. crinita*, but the cells in *E. erecta* are usually more symmetrically arranged in the older parts of the frond, and more rectangular. It is not uncommon from New Jersey north, and appears to be a plant of exposed shores. Europe. Collins (7) 246; (8) 44. *E. clathrata* var. *erecta* Martindale (1) 93. Britton (1) 404. *Ulva clathrata* var. *erecta* Collins (3) 310. EXSICC. Phyc. Bor.-Am., 461.

17. *E. CLATHRATA* (Roth) Grev. Alg. Brit., 181, 1830; J. G. Agardh, Till Alg. Syst., part 3, 153, 1882; De Toni, Syll. Alg., Vol. I, 133, 1889. Frond filiform, cylindrical or compressed, much branched in all directions, the branches tapering from base to summit, but not ending in a single series of cells; cells rectangular, usually longer than broad, always in longitudinal series, the chromatophor noticeably smaller than the cell. Plate 43, fig. 4, portion of surface of main filament.

A common and variable species, differing from all the preceding except *E. Hopkirkii* and *E. erecta* in having a real system of branching of various orders; also in the chromatophor smaller than the cell, which, with the fact that the cells in adjacent series are usually alternate, gives a distinctly net-like appearance to the frond. It seems to be fairly common all along the Atlantic coast, and occurs also at Bering Island in the Pacific. Europe, West Indies, Tas-

mania, New Zealand. Harvey (1) 57, in part. Farlow (1) 292; (2) 712; (3) 379. Robinson (1) 166. Hervey (1) 51. Kjellman (2) 52. Britton (1) 401. Collins (7) 246; (8) 44. *Ulva clathrata* Farlow (4) 44. Collins (3) 310; (6) 78. Dame & Collins (1) 157. Martindale (1) 93.

Forma *prostrata* LeJolis, Algues Marines de Cherbourg, 50, 1863. Fronds densely branched, prostrate, often matted. In salt marshes near Boston, Mass. *Ulva clathrata* var. *prostrata* Martindale (1) 93. Britton (1) 401. *U. clathrata* var. *Rothiana* f. *prostrata* Farlow (4) 44. Dame & Collins (1) 157. EXSICC. Phyc. Bor.-Am., 459; Alg. Am.-Bor., 215.

18. *E. RAMULOSA* (Eng. Bot.) Hook., British Flora, Vol. II, 319, 1833; J. G. Agardh, Till Alg. Syst., part 3, 154, Pl. IV, figs. 117, 118, 1882; De Toni, Syll. Alg., Vol. I., 134, 1889. Frond tubular, rather stiff, much branched; branches with short spine-like ramuli; cells rather rounded, showing longitudinal series only in the ultimate divisions. Plate 43, fig. 6, tip of branch.

A coarse species, readily recognized by its habit. It appears to be not uncommon along the southern part of the Atlantic coast, but rare in New England. The color is usually a rather deep or dark green; the main branches are often quite long, and are everywhere beset with short tapering ramuli; the cells are rounded, almost entirely occupied by the chromatophor; without any definite arrangement except in the ramuli. Europe, Australia, New Zealand. Collins (8) 44. *E. clathrata* var. *ramulosa* Kemp (1) 41. *Ulva clathrata* var. *ramulosa* Farlow (4) 44. Collins (3) 310. *U. clathrata* var. *uncinata* Martindale (1) 93. Britton (1) 401.

19. *E. ACANTHOPHORA* Kütz., Sp. Alg., 479, 1849. J. G. Agardh, Till Alg. Syst., part 3, 157; De Toni, Syll. Alg., Vol. I, 135, 1889. Frond more or less proliferously branched, the branches usually somewhat enlarged upward, beset with numerous short, spine-like ramuli, with broad base and acute tip, cells 6–8 μ diameter, roundish angular, showing no longitudinal arrangement except indistinctly at the tips of the ramuli. Plate 43, fig. 5, tip of branch.

Somewhat resembles *E. ramulosa*, but the cells are much smaller, with hardly any indication of longitudinal arrangement; the substance is less firm, and the color is lighter. The fronds seem to collapse irregularly in drying. The spine-like ramuli vary in abundance, sometimes almost covering the frond; the regular branches are not very numerous, and seem quite distinct from the ramuli. It occurs on the California coast (Brandege), and is one of the few species that occur also in fresh water, having been collected by Miss S. P. Monks in the Santa Paula mountains, California, at an altitude of over 300 meters, and by Miss G. R. Crocker in Alameda Creek, California; West Coast of South America, New Zealand and Tasmania. EXSICC. Phyc. Bor.-Am., 515.

ILEA Ag.

Frond filamentous, hollow, the cells single, or in twos and fours, enclosed in the wall of the mother cell, and arranged in distinct longitudinal series in all parts of the frond.

I. FULVESCENS (Ag.) J. G. Agardh, Till Alg. Syst., part 3, 115, 1882; *Enteromorpha aureola* De Toni, Syll. Alg., Vol. I, 131, 1889. The only species; characters of the genus. Plate 41, fig. 22, cross section; fig. 23, proliferous branching; fig. 24, surface.

This plant grows in dense tufts, the filaments usually 5 to 20 cm. long, the diameter being seldom over 2 mm. The fronds are soft and gelatinous, the color varying from dark green to brownish or yellow. The cells have a distinctive *Gloeocapsa*-like arrangement, and are in longitudinal series so distinct that by pressure on the cover glass they readily separate, appearing like distinct filaments of one or two cells wide.

It grows best in places where streams of fresh water empty into the sea, occupying the space between high and low water marks; so that twice in each day its medium is changed from sea water to quite fresh water, and back again. It appears to be common from Maine to New Jersey, and is found in salt springs at Sussex, New Brunswick, 20 miles from the sea (Ganong). Europe, So. Pacific.

The dimensions given above will cover all accessible specimens or records, except that at Cutler, Me., in July, 1902, the writer collected this species with fronds over a meter long and two cm. in diameter, and similar specimens were collected by Dr. Farlow in the same month at Campobello, New Brunswick. The localities are only fifteen miles apart, and near the mouth of the Bay of Fundy. It may be that the great range of the tide here furnishes the conditions of this unusual development. Ganong (1) 16. Collins (8) 44. *Capsosiphon aureolus* Collins (7) 245. *Ulva aureola* Collins (2) 131; (3) 310; (6) 78. Martindale (1) 93. Britton (1) 401. Exsicc. Phyc. Bor.-Am., 264.

DOUBTFUL REFERENCES.

ULVA CLATHRATA Pike (1) 106. Bennett (1) 95. Anderson (1) 218.

U. COMPRESSA Anderson (1) 218.

U. ENTEROMORPHA var. COMPRESSA Pike (1) 106. Bennett (1) 95. Britton (1) 400. Martindale (1) 93. Hay (1) 33. Hay & MacKay (1) 63.

U. ENTEROMORPHA var. INTESTINALIS Pike (1) 106. Britton (1) 400.

U. HOPKIRKII Pike (1) 106.

U. INTESTINALIS Anderson (1) 218.

U. LACTUCA Bailey (1) 402. Curtis (1) 156. Hall (1) 112. Pike (1) 106.

U. LACTUCA var. LACTUCA Pike (1) 106. Bennett (1) 95.

U. LACTUCA var. LATISSIMA Howe (1) 167.

U. LACTUCA var. RIGIDA Pike (1) 106.

U. LATISSIMA Postels & Ruprecht (1) 21. Bailey (1) 402. Hooper (1) 30. Hall (1) 112.

ENTEROMORPHA CLATHRATA Hooper (1) 30. Kemp (1) 41. Olney (1) 9.

E. COMPRESSA Postels & Ruprecht (1) 21. Bailey (1) 402. Hooper (1) 30. Bailey & Harvey (1) 163. Hervey (2) 176. Ashmead (2) 96. Curtis (1) 156. Kemp (1) 41. Harvey (1) 50. Eaton (1) 348; (2) 5. Melvill (1) 265. Hall (1) 112. Murray (1) 260. Olney (1) 9. Wolle (1) 107. Fowler (1) 48.

E. ERECTA Hooper (1) 30. Olney (1) 42. Bailey (1) 402.

E. INTESTINALIS Bailey (1) 402. Hooper (1) 30. Harvey (2) 176. Curtis (1) 156. Kemp (1) 41. Olney (1) 42. Wolle (1) 107.

MONOSTROMA PULCHRUM Pike (1) 106. Martindale (1) 92.

M. BLYTHII Martindale (1) 92.

EXPLANATION OF PLATES. — Plate 41. Fig. 1, *Ulva Lactuca* var. *rigida*. Figs. 2, 3, *Monostroma fuscum* forma *Blythii*. Figs. 4, 5, *M. Grevillei*. Figs. 6, 7, *M. arcticum*. Figs. 8, 9, *M. pulchrum*. Figs. 10, 11, *M. leptodermum*. Figs. 12, 13, *M. undulatum*. Figs. 14, 15, *M. crepidinum*. Figs. 16, 17, *M. quaternarium*. Figs. 18, 19, *M. latissimum*. Figs. 20, 21, *M. Groenlandicum*. Figs. 22, 23, 24, *Ilea fulvescens*.

Plate 42. Figs. 1, 2, *Enteromorpha micrococca*. Fig. 3, *E. flexuosa*. Fig. 4, *E. torta*. Fig. 5, *E. prolifera*. Figs. 6, 7, *E. intestinalis*. Fig. 8, *E. Linza*. Figs. 9, 10, *E. minima*. Figs. 11, 12, *E. compressa*. Fig. 13, *E. marginata*. Fig. 14, *E. crinita*. Figs. 15, 16, *E. percursa*.

Plate 43. Fig. 1, *Enteromorpha cruciata*. Fig. 2, *E. erecta*. Fig. 3, *E. Hopkirkii*. Fig. 4, *E. clathrata*. Fig. 5, *E. acanthophora*. Fig. 6, *E. ramulosa*.

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